DOCUMENT RESUME

ED 130 905 SE 021 647

AUTHOR	Whitfield, Melvin
TITLE	Protist: The "Unseen" Kingdom. [Aids to Individualize the Teaching of Science, Mini-Course Units for Grades 7, 8, and 9.]
INSTITUTION	Frederick County Board of Education, Md.
PUB DATE	73
NOTE	23p.; For related Mini-Course Units, see SE 021 624-656; Not available in hard copy due to marginal legibility of original document
AVAILABLE FROM	Frederick County Board of Education, 115 East Church St., Frederick, MD 21701 (no price quoted)
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	*Biology; Individualized Instruction; Instructional Materials; Junior High School Students; *Microbiology; Process Education; *Science Education; Science Materials; Secondary Education; *Secondary School Science
IDENTIFIERS	Maryland (Frederick County); Minicourses; Protistology

ABSTRACT

This booklet, one of a series developed by the Frederick County Board of Education, Frederick, Maryland, provides an instruction module for an individualized or flexible approach to 7th, 8th, and 9th grade science teaching. Subjects and activities in this series of booklets are designed to supplement a basic curriculum or to form a total curriculum, and relate to practical process oriented science instruction rather than theory or module building. Included in each booklet is a student section with an introduction, performance objectives, and science activities which can be performed individually or as a class, and a teacher section containing notes on the science activities, resource lists, and references. This booklet introduces pupils to the study of protists. The estimated time for completing the activities in this module is 4-6 weeks. (SL)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

AIDS TO INDIVIDUALIZE THE TEACHING OF SCIENCE

ED130905

PERMISSION TO REPRODUCE THIS COPYRIGHTED MATERIAL HAS BEEN GRANTED BY

Marvin G. Spencer

TO ERIC AND ORGANIZATIONS OPERATING UNDER AGREEMENTS WITH THE NATIONAL INSTITUTE OF EDUCATION. FURTHER REPRODUCTION OUTSIDE THE ERIC SYSTEM REQUIRES PERMISSION OF THE COPYRIGHT OWNER

MINI-COURSE UNITS

BOARD OF EDUCATION OF FREDERICK COUNTY

1973

SE 021 647

Frederick County Board of Education

Mini Courses for

Life, Earth, and Physical Sciences

Grades 7, 8, and 9

Committee Members

Life Science	-	Terrence Best Paul Cook Sharon Sheffield Melvin Whitfield
Earth Science	-	Nelson Ford John Fradiska John Geist
Physical Science	-	Ross Foltz Kenneth Howard Fred Meyers

Dr. Alfred Thackston, Jr.
Assistant Superintendent for Instruction

Marvin Spencer
Science Supervisor

Frederick, Maryland

1973

Frederick County Board of Education
Frederick, Maryland

Mr. G. Hunter Bowers, Jr.
President

Mr. Frederick L. Smith, Vice President
Mrs. Frances W. Ashbury
Mr. William B. Barnes
Mr. Clement E. Gardiner
Mrs. Mary Condon Hodgson
Mrs. Doty Remsberg

Dr. John L. Carnochan, Jr.
Superintendent of Schools

Copyright 1973

Frederick County Board of Education

FOREWORD

The contents represented in these modules of instruction, called mini courses, is an indication of our sincere desire to provide a more individualized and flexible approach to the teaching of science.

Data was accumulated during the school year relative to topics in life, earth, and physical science that were felt to be of greatest benefit to students. The final selection of topics for the development of these courses during the workshop was made from this information.

It is my hope that these short courses will be a vital aid in providing a more interesting and relevant science program for all middle and junior high school students.

Dr. Alfred Thackston, Jr.
Assistant Superintendent for Instruction

ACKNOWLEDGEMENTS

Mrs. Judy Fogle, Typist
Miss Patti Lockard, Typist
Mr. Victor Gosnell, Printing Assistant
Mrs. Helen Shaffer, Printing Technician
Mr. Darl Hinkle and Staff, Instructional Materials Center

PROTIST: THE "UNSEEN" KINGDOM

Prepared by

Melvin Whitfield

CONTENTS

Student Section (white pages)

Introduction

Objectives

Activities

Teacher Section (blue pages)

References

Audio-Visual Aids

Notes on Activities

Estimated Teaching Time

4-6 weeks

PROTIST: THE "UNSEEN" KINGDOM

INTRODUCTION:

As we go about our daily lives, we see countless living things. Most of these living things we classify as plant or animal. Some organisms possess some of the characteristics of both plants and animals, but are different from either group. Because of this a third kingdom of living things has been devised and we call it the protist kingdom. Scientists, however still cannot agree just which organisms should be place in the protist kingdom.

Protist are found everywhere, but hardly ever seen. They are found in ponds, streams, lakes, grass, snow, oceans, mud, soil, and just about any place else you can think of. They float along through the air on particles of dust and can travel thousands of miles carried by the wind. "Why was I not aware of these before?" you might ask. The protist are usually one-celled and most are microscopic (can be seen only with the aid of a microscope). With the aid of a microscope, a whole new world will be opened up to you. You will discover many new things and be made more aware of things you already know.

OBJECTIVES:

Each student should be able to:

1. describe asexual and sexual reproduction.
2. use the microscope and focus the microscope to study microscopic life.
3. identify by pictures, drawings, or actually seeing:

a. flagellum	h. ameba
b. cilia	i. euglena
c. pseudopodia	j. paramecium
d. three types of bacteria	k. volvox
e. mold	l. rotifer
f. algae	m. yeast
g. colonies of protists	

4. describe the importance of protists in food chains.
5. identify several diseases caused by protists.
6. make a list of beneficial uses of protists.
7. describe fission, conjugation, and budding.
8. write the scientific names of the 3 types of bacteria when the common name or drawing is presented.
9. list ways to reduce the chance of disease caused by protists studied.

10. Define:

A. Innoculate	D. Parasite	H. Cyst
B. Sterile	E. Spore	I. Multicellular
C. Unicellular	F. Microorganism	

11. List the ways of locomotion of the protists studied.

12. List the methods of getting food for the protists studied.

13. Make drawings of protist commonly found in pond water and label the major parts.

14. Identify cell parts in plant and animal cells and be able to distinguish between plant and animal cells.

ACTIVITIES:

A. Collecting pond water.
Every student is to collect at least one jar of pond water. Get a small jar with a lid, preferably a baby food jar to collect your sample. There will be a number of farm ponds where you can collect your samples. If you are unable to get to a pond, you may collect water from a spring, swampy area, or some other source such as this. A stream with a stagnant area could also be used. If, for some reason, you cannot get any water, give a jar to a friend of yours that can and this will be acceptable. When collecting your samples, put a small amount of the aquatic vegetation that you will see in the water. Put a label on your jar with your name and section on it and bring this in as soon as possible. One week maximum.

B. Read pp. 152-159 in the text Living Things, 1966 edition, and answer questions 1-5, 8, & 9 on page 159.

C. In the text Living Things, 1966 edition, read pp. 160-165 and answer questions 1-5 on page 167.

D. LAB: Plant and Animal Cells

Introduction:

All living things are composed of a basic structural and functional unit of life called the cell. Some living things are made of one cell and are called unicellular. They are usually microscopic. Other living things are composed of many cells and are called multicellular.

There are certain cell structures found in all cells of all living things. In this investigation, we will look for the ways plant and animal cells are alike as well as for the ways in which they differ.

Problem:

How are plant and animal cells alike, and how are plant and animal cells different from each other?

Materials:

Zoomscope, onion, Elodea, water, slides, dye, toothpicks, forceps, pond water.

Procedure-Method:

A. Onion Cells: Cut a small wedge out of a peeled onion and separate the layers. Attached to the inside of a layer is a fine, transparent "skin". Pull this away from the onion section and place a small portion of it in a drop of water on a slide. Make sure it does not overlap. Examine at 50X to 200X.

1. What parts of a cell can you see?

Add a drop of iodine solution or methylene blue. Observe.

2. What parts of the onion cell can you see better after staining?

3. On a sheet of drawing paper make a sketch (remember your direction for drawings) of the onion cells at 50X and at 200X. Label the parts.

B. Elodea: Obtain a small leaf from the water plant, Elodea. Mount the leaf in a drop of water. Observe 50X to 200X.

4. Make a drawing of the Elodea leaf. Label.

Extra- Add a drop of sugar solution to the edge of the drop of water holding the leaf. Under high power (200X) observe one cell to see if a change is brought about by the sugar solution. Is there movement inside the cells?

C. Cheek Cells: Epithelial cells, animal: To obtain cells, gently scrape the inside of your cheek with the blunt end of a clean toothpick. This grayish material should contain several skin (epithelial) cells. Smear the material from the end of the toothpick into a drop of water on a glass slide. Spread it out. (BREAK IN HALF AND THROW USED TOOTHPICK IN WASTE BASKET). The cells are transparent, therefore hard to see. The less light you use, the better. Move the slide around to find the best sample of cells (these will be unwrinkled and fitted together like a puzzle.) Add dye to stain.

5. Make a drawing, label the parts.

D. Animal Cells: Obtain some pond water. Observe a drop of it. How do the structures within these organisms compare with the cheek cells, the Elodea, the onions?

THINKING THINGS OUT:

1. Why were the cheek cells easy to remove?

2. What, do you think, was the function of the green bodies in the Elodea?

3. Did you see green bodies in the onion cells? Why, or why not?

4. Did you really see the cell wall and the cell membrane in the onion and Elodea? If not, why not?

5. What was the biggest difference between the organisms in the pond water and the others you observed?

ACTIVITIES (continued):

E. Observing bacterial shapes

Obtain a prepared microscope slide which has bacteria on it from your teacher. With your microscope (remember microscope techniques!) observe the slide. Look under both low power and high power (this will vary according to microscope you use). Now, do the following:

1. Make a sketch on drawing paper of the different shapes of bacteria you observed. When doing your drawings tell the power at which you are drawing.

2. Write a brief description of each bacterial shape you observed.

F. Reading assignment. From the text The Biological Sciences, read pp. 96-107.

G. LAB: Examining Nitrogen - Fixing Bacteria

Obtain a leguminous plant, such as clover, alfalfa, or beans, which still have soil on their roots. Look for swellings or nodules on the roots. These nodules are caused by nitrogen-fixing bacteria which have gotten on the root tissue.

Wash off your root. Place a nodule between 2 glass microscope slides. Wrap the slides in a paper towel. Carefully press down on the slides to crush the nodule. Be very careful not to break the slides. On the bottom slide, place a drop of methylene blue stain on the crushed nodule. After the stain has been on for 2 minutes, blot off the excess stain with a paper towel. Examine your slide under high power. If you can see bacteria, draw and describe its shapes on drawing paper following the rules for drawings.

H. Read from the text, The Biological Sciences, pp. 110-128.

I. Read from the text, Life Science - A Modern Course, 1965 edition, pp. 90-93. On notebook paper do the following: 1.) Page 93 and 94 answer questions 1-10 and 2.) On page 94 answer Questions for Discussion 1-6.

J. Read from the text, Life Science - A Problem Solving Approach, pp.125-132.

K. Read in the text, Life - Its Forms and Changes, the following pages: 76-82; 239-242; 308-314.

L. LAB: From the text, Life Science - A Problem Solving Approach, do Problem 8-1 on pages 133-135.

M. LAB: A Look at Pond Water Samples

Problem:

What do protists look like?

Materials:

Microscope, water drop slide, cover slide, water samples brought in by you, dropper.

Introduction:

You are now aware of life on the microscopic level. Protists come in as many shapes as you can imagine. In this lab, you are to examine as many different samples as you can in one period. You are to look at your pond water and other samples brought in by your classmates. Your teacher will have samples for you to examine also.

Method:

With a dropper, get some pond water from your jar and put one drop of water on a water slide. Don't stir your water when you put in the dropper. Take your first sample from the top of the water. Put a cover slide over the drop. Move the slide slowly from side to side to expose entire drop of water in order to see all of the contents of the water. Be sure to have sufficient light, but too much light will cause the protists to fade out because many are clear. CAUTION: Never reflect direct sunlight into your microscope with your mirror. Damage can be done to the eyes.

Now, after examining your first drop, clean off your slide and get a second drop from the middle of your jar of pond water (remember, don't stir your water). Examine as above.

Get a third drop of water from the bottom of your jar and examine as above.

Finally, get samples from other students and teacher samples from the front of the room. Examine as before.

Results:

1. Did you see living organisms?
2. Are they moving or not?
3. Did you see any taking in food?
4. What cell parts could you see?
5. Were any reproducing? If yes, describe how.
6. Describe movement of the organisms observed.
7. Make a sketch of the organisms you see. Label all parts observed.

N. LAB: Observing Paramecium

Introduction:

Paramecia are one of the most common protist found in pond water. They move about rapidly through the water and are easy to examine because they are quite large. As a means of defense, paramecia discharge a filament (looks like tiny threads) called trichocysts to ward off small enemies. If you look closely enough, paramecia can be seen with the naked eye. They will look like tiny white specks moving about.

Materials:

Paramecium culture, microscope, water drop slide, cover slide, dropper, salt, vinegar, carmine powder, iodine.

Method:

Obtain a drop of paramecium culture from the jar labeled paramecium. If your pond water had paramecia, you can use it. Remember - don't stir the water. Put a drop on a clean water drop slide. It is helpful to get some scum from the water because paramecia will be feeding here. Another aid is to add a few fibers of cotton to the slide and put the drop on the cotton. The cotton will slow the paramecia for easier observation. Add a cover slide and observe paramecia.

Reactions of Paramecium: (You will need a new drop of culture and a clean slide and slide cover for each test. Note response(s) for each test.)

1. Place a single grain of table salt to your drop of culture and then add a cover slide. Observe immediately.

2. Soak some thread in vinegar. Place the thread in a drop of culture and add cover slide. Observe immediately.

3. Add a drop of iodine to your culture while observing your paramecium.

4. Place several carmine crystals to your drop of culture. Add cover glass and observe paramecia.

5. Place a strong light to one side of your microscope slide and observe in which direction the paramecia seem to move.

Results:

1. By what means does a paramecium move about? Describe this movement.
2. What happened when you added the grain of salt?
3. What happened when you added the vinegar?
4. What happened when you added the iodine?
5. What happened when you added the carmine crystal?
6. How did the paramecia respond to light?
7. What is unusual about the nucleus in a paramecium?
8. Draw a paramecium and label all parts observed.

O. LAB - From the text, Life Science - A Problem Solving Approach, do Problem 9-2 on pp. 159-162.

P. LAB: What Are Some Types of Bacteria Colonies?

Introduction:

Bacteria are one of life's smallest living things. They are found just about everywhere and can reproduce rapidly - about once every 20 minutes if conditions are favorable. Bacteria are invisible to the naked eye and can hardly be seen with microscopes unless the power is high enough. When bacteria grow in colonies (masses of bacteria growing together), we can observe them easily. In this lab exercise, we will find places where bacteria are found and grow them for viewing.

Materials:

Petri dish with sterilized agar medium, marking pen.

Method:

Obtain a petri dish with nutrient agar in it. Take a marking pen and divide it into 4 parts. Determine four sources of bacteria. Example: comb, hair, coin, finger, soil, pencil, etc. Touch your source to the agar gently so as not to break the agar nutrient. Cover your petri dish patting your name and section on it. Place in warm, dark place. Check daily for next 3 days. Save your results for the next lab - do not discard petri dish. Record on notebook paper your sources and match the number to source. Example: 1 - comb; 2 - finger; etc.

Results:

1. When did bacteria growth begin to show?

2. Were any areas free of microorganisms?

3. Which area produced the most growth?
   Why did this area produce the most growth?

4. Do all areas look the same or is there a difference in the appearance? Why is this true?

5. What is necessary for microorganisms to grow?

6. What colors appear in your petri dish?

7. What grew on the nutrient agar besides bacteria? Why is this so?

8. How many different colonies of bacteria formed?

9. On drawing paper, draw the outlines of the different types of colonies that grew in your dish.

ACTIVITIES (continued):

Q. LAB: In the text Life Science - A Problem Solving Approach do Problem 10-2 on pp. 177-180.

R. Extra Credit Labs: You may do the following labs for extra credit if you finish all assigned work and time permits.

LAB: Life Science Skillcards, Charles E. Merrill Publishing, Co., number 5, "Bacteria - Food Spoilage".

LAB: Life Science Skillcard, #8, "Microscopic Life - Bread Molds".

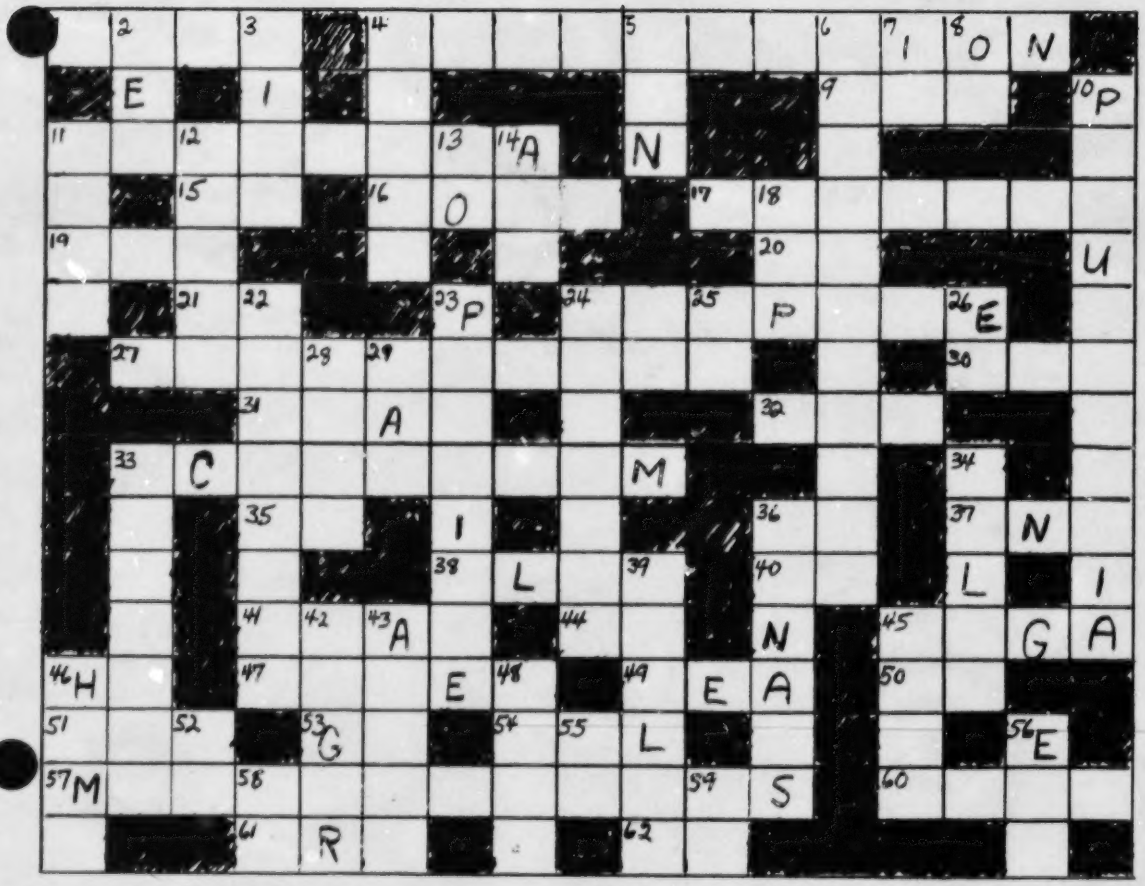
LAB: From text Life Science - A Problem Solving Approach, do Problem 9-1 on pp. 152-157.

S. Chart comparing the protist.
From the work you have done so far, you should be able to complete the chart on microorganisms found on the next page.

T. Complete this crossword puzzle on protozoa and turn in to the teacher when complete.

Comparison of Protists

Name	Sketch	Method of Movement	Produce food or consume it	Reproduction	Reasons for importance
Paramecium					
Euglena					
Ameba					
Bacteria					
Yeast					
Mold					
Algae					



Across

1. A culture medium.
4. During _____, two paramecia unite by joining together along an oral groove.
9. The dinoflagellates are responsible for the _____ tide.
11. Whiplike strands that aid in movement are _____.
15. Manuscript (abbr.).
16. Electrified particles.
17. A _____ is a space containing fluid in the cytoplasm of the cell.
19. Protozoa have _____cell.
20. Social hierarchy (initials).
21. Beautiful paramecium (initials).
25. A _____ is an asexual reproductive cell.
27. The _____is often called the "slipper animal" because of its shape.
30. The paramecium has _____different kinds of nuclei.
31. Egg-shaped.
32. Organ of sight.
33. The outer layer of thin, clear, cytoplasm in ameba is_____.
35. Old World (abbr).
36. Mountain Time (abbr).
37. Limit or boundary.
38. Stout, clumsy shoe.
40. Organized society (abbr).

Across

41. The paramecium mouth is at the end of the _____ groove.
44. New Universe (initials).
45. Ameba eats green _____ by extending pseudopodia and surrounding it.
46. Masculine pronoun.
47. Directed toward a mark.
49. Grassland.
50. New York (abbr.).
51. Encyclopedia (abbr.).
53. Depart.
54. Shells of marine foraminifera are important components of many geo-fossils for mapping _____ -bearing formations.
57. The large nucleus in paramecium is the _____.
60. Protozoa represent a unicellular form of _____.
61. A unit of energy or work.
62. Township (abbr.).

Down

2. A jellylike material.
3. Equips.
4. Tiny, hairlike projections of protoplasm are _____.
5. Vase.
6. For defense, the _____ of the paramecium explode special threads into the water.
7. That is.
8. Theoretical force.
10. "False feet" of ameba are _____.
11. The ameba obtains _____ from the water by using pseudopodia.
12. The _____ is referred to as "animated jelly".
13. Behold!
14. Social insect.
18. Venomous snake.
22. One-celled animals are _____.
23. Thickened cell membrane that gives paramecium definite shape is _____.
24. One method of reproduction in paramecium is _____.
25. Small member (abbr.).
26. Latin for "and".
28. Declare openly.
29. Representation of the surface of the earth or a part thereof.
33. Animal with chloroplasts is _____.
34. Ameba looks like flowing _____.
36. Some flagellates, such as the tricho_____, cause infectious diseases in man.
39. Mouth cavity of paramecium leads to _____.
42. Severity.
43. The subject of ciliates is popular _____ students of heredity.
45. Undigested food passes out through _____pore.
46. An aromatic plant cultivated for its tough fiber.
48. A wharf.
52. Cubic centimeters (abbr.)
55. International league (abbr.).
56. Newt.
58. Regarding (abbr.).
59. United Press (abbr.).

A. References:

1. Brandwein & others; Life- Its Forms and Changes; Harcourt, Brace & World, Inc., 1968.

2. Carter & others; Life Science - A Problem Solving Approach; Ginn & Co., 1971.

3. Fitzpatrick & Hole; Modern Life Science; Holt, Rinehart & Winston, Inc., 1970

4. Frazier & Smith; The Biological Sciences; Laidlaw Brothers; 1971.

5. Mason & Peters; Life Science- A Modern Course; D. Van Nostrand Co., Inc., 1965.

6. Tilsner, William; Life Science Skillcards; Charles E. Merrill Publishing Co. 1969.

B. Audio-Visual Aids

1. Available from I.M.C.

Films:
F675 Life in a Drop of Water (11 min.)
F664 Paramecium, Euglena & Ameba (15 min.)
F561 The Protist Kingdom (14 min.)
F479 Microorganisms That Cause Disease (11 min.)
F 208 The Worlds of Dr. Vishniac

Filmstrips:

FS 580 Algae
FS 580 Bacteria
FS 591 One-Celled Animals
FS 591 Protozoa

Loops:

L 574 Animal life in a drop of water
L 574 (super) Comparative sizes of microscopic animals
L 574 (super) Feeding activity of the ameba
L 574 (super) Locomotion of the ameba
L 574 Microscopic animals - protozoa
L 574 Microscopic water animals
L 574 (super) Paramecium

C. Notes on Activities

a. You should have some students collect extra jars of pond water. Have some students bring in alfalfa, hay, leaves, and grass to put in some jars of pond water to aid in growth of microscopic organisms. Have extra jars available.

b. Can substitute if you wish.

c. Can substitute.

d. Have students bring in onion, lettuce leaves and pond water before hand. Check with P. J. Hummer at TJ for elodea and protist cultures.

e. Have prepared slides of bacteria.

f. Can substitute.

g. Have students or you can bring in entire plant of bean, alfalfa, or clover.

h. Can substitute.

i. Can substitute.

j. Can substitute.

k. Can substitute.

l. You will need alfalfa leaves or grass, lettuce leaf, cotton, and extra jars on hand.

m. Have pond water on hand and cultures from culture center (P. J. Hummer - TJ).

n. Make sure you have materials called for available.

o. Have students bring bread from home. It should be bakery or home made bread. "Store bought bread" will have preservatives which will alter this lab.

p. Have the petri dishes with agar prepared for each student before they reach this lab. In the text, A Sourcebook for the Biological Sciences by Morholt, Brandwein, and Joseph; on pages 380-384 is a formula for making nutrient agar.

q. Have several types of antiseptics on hand and have students bring in some of their own.

r. You may substitute others if you wish.

s. Can substitute another activity.

t. Can substitute or use for extra credit. Key is on next page.

KEY

ACROSS

1 Agar
4 Conjugation
9 Red
11 Flagella
15 Ms
16 Ions
17 Vacuole
19 One
20 Sh
21 Bp
25 Spore
27 Paramecium
30 Two
31 Oval
32 Eye
33 Ectoplasm
35 Ow
36 Mt
37 End
38 Clog
40 Os
41 Oral
44 Nu
45 Alga
46 He
47 Aimed
49 Lea
50 NY
51 Enc
53 Go
54 Oil
57 Macronucleus
60 Life
61 Erg
62 Tp

DOWN

2 Gel
3 Rigs
4 Cilia
5 Urn
6 Trichocysts
7 Ie
8 Od
10 Pseudopodia
11 Food
12 Ameba
13 Lo
14 Ant
18 Asp
22 Protozoa
23 Pellicle
24 Fission
25 Sm
26 Et
28 Avow
29 Map
33 Euglena
34 Jelly
36 Monads
39 Gullet
42 Rigor
43 Among
45 Anal
46 Hemp
48 Dock
52 CC
55 Il
56 Eft
58 Re
59 Up

ADDITIONAL SCIENCE MINI-COURSES

LIFE SCIENCE	Prepared by
A Study for the Birds	Terrence Best
Creepy Critters (Snakes)	Terrence Best
How's Your Plumbing?	Paul Cook
Guess Who's Been Here for Dinner	Paul Cook
Plants - The "Other" Living Things	Sharon Sheffield
Let's Look at You - The Human Organism	Sharon Sheffield
Classification: Why is There a Need?	Melvin Whitfield
Protist: The "Unseen" Kingdom	Melvin Whitfield

EARTH SCIENCE	
Coastline Development	Nelson Ford
Ocean Currents	John Fradiska
Features of the Ocean Floor (Ocean Floor Topography)	John Fradiska
Space and Its Problems	John Geist
Invertebrate Fossils: Clues to the Distant Past	John Geist
An Attempt towards Independent Study in Astronomy	John Geist

PHYSICAL SCIENCE	
Household Chemistry	Ross Foltz
Notions on Motions	Kenneth Howard
Environmental Chemistry	Fred Meyers